Ecosystem as the Basic Unit in Ecology

The term *ecosystem* was proposed by Tansley (*1*) as a name for the interaction system comprising living things together with their nonliving habitat. Tansley regarded the ecosystem as including "not only the organism-complex, but also the whole complex of physical factors forming what we call the environment." He thus applied the term specifically to that level of biological organization represented by such units as the community and the biome. I here suggest that it is logically appropriate and desirable to extend the application of the concept and the term to include organization levels other than that of the community.

In its fundamental aspects, an ecosystem involves the circulation, transformation, and accumulation of energy and matter through the medium of living things and their activities. Photosynthesis, decomposition, herbivory, predation, parasitism, and other symbiotic activities are among the principal biological processes responsible for the transport and storage of materials and energy, and the interactions of the organisms engaged in these activities provide the pathways of distribution. The food-chain is an example of such a pathway. In the nonliving part of the ecosystem, circulation of energy and matter is completed by such physical processes as evaporation and precipitation, erosion and deposition. The ecologist, then, is primarily concerned with the quantities of matter and energy that pass through a given ecosystem and with the rates at which they do so. Of almost equal importance, however, are the kinds of organisms that are present in any particular ecosystem and the roles that they occupy in its structure and organization. Thus, both quantitative and qualitative aspects need to be considered in the description and comparison of ecosystems.

Ecosystems are further characterized by a multiplicity of regulatory mechanisms, which, in limiting the numbers of organisms present and in influencing their physiology and behavior, control the quantities and rates of movement of both matter and energy. Processes of growth and reproduction, agencies of mortality (physical as well as biological), patterns of immigration and emigration, and habits of adaptive significance are among the more important groups of regulatory mechanisms. In the absence of such mechanisms, no ecosystem could continue to persist and maintain its identity.

The assemblage of plants and animals visualized by Tansley as an integral part of the ecosystem usually consists of numerous species, each represented by a population of individual organisms. However, each population can be regarded as an entity in its own right, interacting with its environment (which may include other organisms as well as physical features of the habitat) to form a system of lower rank that likewise involves the distribution of matter and energy. In turn, each individual animal or plant, together with its particular microenvironment, constitutes a system of still lower rank. Or we may wish to take a world view of life and look upon the biosphere with its total environment as a gigantic ecosystem. Regardless of the level on which life is examined, the ecosystem concept can appropriately be applied. The ecosystem thus stands as a basic unit of ecology, a unit that is as important to this field of natural science as the species is to taxonomy and systematics. In any given case, the particular level on which the ecosystem is being studied can be specified with a qualifying adjective—for example, community ecosystem, population ecosystem, and so forth.

All ranks of ecosystems are open systems, not closed ones. Energy and matter continually escape from them in the course of the processes of life, and they must be replaced if the system is to continue to function. The pathways of loss and replacement of matter and energy

frequently connect one ecosystem with another, and therefore it is often difficult to determine the limits of a given ecosystem. This has led some ecologists to reject the ecosystem concept as unrealistic and of little use in description or analysis. One is reminded, however, of the fact that it is also difficult, if not impossible, to delimit a species from its ancestral or derivative species or from both; yet this does not destroy the value of the concept. The ecosystem concept may indeed be more useful when it is employed in relation to the community than to the population or individual, for its limits may be more easily determined on that level. Nevertheless, its application to all levels seems fully justified.

The concept of the ecosystem has been described under many names, among them those of *microcosm* (*2*), *naturkomplex* (*3*), *holocoen* (*4*) and *biosystem* (*5*). Tansley's term seems most successfully to convey its meaning and has in fact been accepted by a large number of present-day ecologists. I hope that it will eventually be adopted universally and that its application will be expanded beyond its original use to include other levels of biological organization. Recognition of the ecosystem as the basic unit in ecology would be helpful in focussing attention upon the truly fundamental aspects of this rapidly developing science.

FRANCIS C. EVANS
Institute of Human Biology,
University of Michigan, Ann Arbor

References

1. A. G. Tansley, *Ecology* **16**, 296 (1935).
2. S. A. Forbes, *Bull. Peoria Sci. Assoc.* (1887).
3. E. Markus, *Sitzber. Naturforsch. Ges. Univ. Tartu* **32**, 79 (1926).
4. K. Friederichs, *Die Grundfragen und Gesetzmässigkeiten der land-und forstwirtschaftlichen Zoologie.* (Parey, Berlin, 1930).
5. K. Thienemann, *Arch. Hydrobiol.* **35**, 267 (1939).

30 January 1956